DETAILED ACTION

1. Regarding the last Non-Final Office Action sent on 6/11/2008, the following corrective action is taken. The period for reply of 3 MONTHS set in said Non-Final Office Action is restarted to begin with the mailing date of this letter.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 3/20/2009 has been entered.

Response to Arguments

3. Applicant's arguments filed on 3/20/2009 have been considered but are moot in view of the new ground(s) of rejection.

1). Applicant's argument – "Each of the independent claims is amended to require that the respective recited communications apparatus or method is operating at a data rate of at least 10Gbps". "Smart et al. did not disclose anything which could suggest to a person of ordinary skill in the art that it would be possible to achieve a significant increase in the bandwidth of an optical communications system through the use of OFDM modulation. This is because Smart et al. were concerned only with data

rates which could also be communicated over the limited bandwidth of RF or wired connections". "[W]hat Smart et al. propose is a modulated signal which can be transmitted over all of these media - including twisted pair cable; coaxial cable; or an RF propagation path, as well as optical fiber". "Similar arguments to those above apply to Dolgonos et al".

Examiner's response – First, Smart et al discloses a system and method that uses multiple carriers to improve the bandwidth efficiency of the communication systems. Smart does not state that while the optical fiber is used as the transmission medium, the data rate is also limited to the one as used for the "twisted pair cable" etc. Smart does not propose that the data rate used in a specific transmission medium (e.g., fiber) must be also suitable to be "transmitted over all of these media - including twisted pair cable; coaxial cable; or an RF propagation path". As disclosed by Smart, the system is used "to improve the bandwidth efficiency of the communication systems", it is well known in the art that the optical fiber communication can provide high bandwidth and high speed of data transmission. And the newly cited prior art, Agazzi, teaches that by the sub-carrier multiplexing techniques, the fiber optic system can provide 10 Gbit/s data rate. Therefore, it is obvious to one skilled in the art that the system of Smart et al can also be used to transmit 10 Gbit/s signals, and should not be limited to the bandwidth of twisted pair cable or coaxial cable etc.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1, 3-9, 11, 12, 16, 20, 22, 23, 27, 28, 32 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smart et al (US 2002/0041637) in view of Shpantzer et al (US 2002/0186435) and Agazzi (US 6,879,640).

1). With regard to claims 1 and 20, Smart et al discloses an apparatus/optical transmitter for generating an optical sub-carrier multiplexed signal (e.g., 311 in Figure 3B, and Figure 9 and 14), comprising

a digital signal processor (e.g., the IFFT 321 and P/S converter 331 in Figure 3B) having a plurality of electrical inputs, in use each receiving an input signal representing data to be carried on a sub-carrier of the optical sub-carrier multiplexed signal (Figures 2 and 3A, [0028], [0073] and [0081]-[0083] etc., the IFFT perform FFT based on the orthogonal frequency division multiplexing), and an electrical output outputting an output signal (the output from the P/S or D/A converter in Figure 3B), and

wherein the output signal of the digital signal processor is the result of a Fourier transform performed on the input signals (Figure 3B, the IFFT performs the Fourier transform).

But, in Figure 3B, Smart does not expressly show: a modulator having an electrical input, in use receiving the output signal from the digital signal processor, and

an optical output, in use outputting the optical sub-carrier multiplexed signal; and the combined data rate of the input signals is at least 10Gb/s, and the modulator utilizes polarization multiplexing.

However, as disclosed by Smart, [0074], the multi-channel medium 112 can be an optical fiber, an optical propagation path, etc., therefore, for the optical transmission via the optical fiber or optical propagation path, it is either obvious to one skilled in the art or inherent that an optical source and modulator (or a directly modulated laser source) must be used in the system for receiving the output signal from the D/A and, and outputting the optical sub-carrier multiplexed signal, so that the SCM signals can be transmitted in the optical fiber or optical transmission path.

As to the polarization multiplexing, to combine two optical signals with orthogonal polarizations is well known in the art. Shpantzer teaches such a system (e.g., Figures 4, 5 and 11 etc); and the system and the optical to electrical converter (e.g., 700 in Figure 5 or 1150 in Figure 11) receiving a polarization diverse optical multiplexed signal. Also note that, Shpantzer teaches a modulator (e.g., Figure 4) having an electrical input (e.g., the Data Source 370) and an optical output (e.g., 342 in Figure 4) and outputting the optical multiplexed signal. And by using the polarization multiplexing, the system capacity can be increased.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply a polarization multiplexing scheme as taught by Shpantzer et al to the system of Smart et al so that the modulator can generate a

polarization diverse optical sub-carrier multiplexed signal (or two optical sub-carrier signal with orthogonal polarizations) and then system capacity can be increased.

With regard to the data rate of at least 10Gb/s, Smart et al discloses that the system is for improving the bandwidth efficiency of the communication systems. It is well known in the art that the optical fiber has higher bandwidth than twisted pair cable or coaxial cable etc. And another prior art, Agazzi, teaches that by the sub-carrier multiplexing techniques, the fiber optic system can provide 10 Gbit/s data rate (column 11, lines 40-65); as shown in Figures 4 and 11 etc, Agazzi discloses an optical sub-carrier multiplexing system comprising: a digital signal processor (the IFFT 407 or 1117 in Figure 4 or 11), a modulator (the Laser Drive Electr. 413 or 1127 in Figure 4 or 11, column 9 line 8-9, column 11 line 3-14), and the combined data rate of the input signals is at lest 10 Gb/s (column 11 line 36-65). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the teaching of Agazzi to the system of Smart et al and Shpantzer so that the system can also be used to transmit 10 Gbit/s signals and the system bandwidth can be efficiently utilized.

2). With regard to claim 3, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 1 above. And Smart et al further discloses a mapper (e.g., 320 in Figure 3B or 1403 in Figure 14, the modulator 320 assigns data bits (symbols) to each of the carriers and modulates the carriers, that is, modulator 320 is a mapper, [0082] and [0174]) having an electrical input (DATA IN of Figure 3B), in use receiving binary data, and a plurality of electrical outputs (Figure 3B, the plurality of electrical outputs from 320) connected to the electrical inputs of the digital signal

processor (Figure 3B, IFFT), wherein the signals carried by the outputs are a representation of the binary data according to a predetermined modulation format (e.g., the QPSK, QAM etc, Figure 3B).

3). With regard to claim 4, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 1 and 3 above. And Smart et al further discloses where the predetermined modulation format is a phase modulation format ([0022] and [0083]).

4). With regard to claim 5, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 1 and 3 above. And Smart et al further discloses where the predetermined modulation format is a differential phase modulation format ([0022] and [0083], and claim 20).

5). With regard to claim 6, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 1 and 3 above. And Smart et al further discloses where the predetermined modulation format is an amplitude modulation format ([0022] and [0083]).

6). With regard to claim 7, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 1 and 3 above. And Smart et al and Shpantzer et al and Agazzi further disclose where the predeteremined modulation format is an amplitude and phase modulation format (Shpantzer: [0063]).

7). With regard to claim 8, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 1 above. And Smart et al further discloses the digital signal processor further comprising a serialiser (e.g., P/S 331 in Figure 3B),

having a plurality of electrical inputs connected to the electrical outputs of the digital signal processor, and an electrical output in use carrying a signal generated by the serialisation of the signals carried on the plurality of electrical inputs to the serialiser.

8). With regard to claim 9, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 1 above. And Smart et al further discloses a digital to analogue converter (the D/A in Figure 3B) having an electrical input connected to the electrical output of the digital signal processor, and an electrical output connected to the modulator (e.g., for optical transmission, an optical source and modulator (or a directly modulated laser source) must be used in the system of Smart. Or Agazzi: Figure 4, the outputs from D/As are multiplexed and sent to the modulator 413), in use the output of the digital to analogue converter being an analogue representation of the digital input signal.

9). With regard to claims 11 and 12, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 1 above. And Smart and Shpantzer et al and Agazzi further disclose wherein the modulator is configured to modulate the amplitude and phase of an optical carrier (Shpantzer: [0063]); and wherein the modulator comprises two Mach-Zehnder structures (Shpantzer: e.g., 830a and 830b, or 830c and 830d, Figure 4, [0063]), connected to an optical combiner (e.g., Figure 4, 840a or 840b).

10). With regard to claim 16, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 1 above. And Smart et al further discloses a

forward error correction coder (e.g., the FEC 1402 and 1412 in Figure 14) connected to the digital signal processor, in use applying forward error correction coding to the data.

11). With regard to claims 22 and 34, Smart et al discloses an apparatus/receiver for receiving an optical sub-carrier multiplexed signal (e.g., 313 in Figure 3B, and Figure 9), the apparatus comprising

an A/D converter (323 in Figure 3B), in use receiving the sub-carrier multiplexed signal and outputting an electrical signal, and

a digital signal processor (e.g., the P/S 332 and IFFT 324 etc in Figure 3B) having an electrical input, in use receiving the output of the A/D converter, and a plurality of electrical outputs, in use each carrying a signal representing data carried on a sub-carrier of the optical sub-carrier multiplexed signal ([0028], [0073] and [0081]-[0088] etc., the IFFT perform FFT based on the orthogonal frequency division multiplexing),

wherein, the outputs of the digital signal processor are the result of a Fourier transform performed on the input signal (the IFFT 324 performs the Fourier transform on the input signal).

But, in Figure 3B, Smart et al does not expressly show the apparatus for receiving a polarization diverse optical sub-carrier multiplexed signal, and an optical to electrical converter, in use receiving a polarization diverse optical sub-carrier multiplexed signal, and the combined data rate of the signals carried by the plurality of electrical outputs is at least 10 Gb/s.

However, as disclosed by Smart, [0074], the multi-channel medium 112 can be an optical fiber, an optical propagation path, etc., therefore, for the optical transmission via the optical fiber or optical propagation path, it is either obvious to one skilled in the art or inherent that an optical to electrical converter must be used in the system to convert the optical signal to electrical signal and then to the A/D converter 323, and outputting the electrical signal, so that the optical communication can be utilized, and the SCM signals can be received via the optical fiber or optical transmission path.

As to the polarization multiplexing, to combine two optical signals with orthogonal polarizations is well known in the art. Shpantzer teaches such a system (e.g., Figures 4, 5 and 11 etc); and the system has the optical to electrical converter (e.g., 700 in Figure 5 or 1150 in Figure 11) receiving a polarization diverse optical multiplexed signal. And by using the polarization multiplexing, the system capacity can be increased.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply a polarization multiplexing scheme as taught by Shpantzer et al to the system of Smart et al so that the optical to electrical converter receives a polarization diverse optical sub-carrier multiplexed signal (or two optical sub-carrier signal with orthogonal polarizations) and then system capacity can be increased.

With regard to the data rate of at least 10Gb/s, Smart et al discloses that the system is for improving the bandwidth efficiency of the communication systems. It is well known the optical fiber has higher bandwidth than twisted pair cable or coaxial cable etc. And another prior art, Agazzi, teaches that by the sub-carrier multiplexing techniques, the fiber optic system can provide 10 Gbit/s data rate (column 11, lines 40-

65); as shown in Figures 4, 5, 11 and 13 etc, Agazzi discloses an optical sub-carrier multiplexing system comprising: a digital signal processor (the IFFT 407 or 1117 in Figure 4 or 11), a modulator (the Laser Drive Electr. 413 or 1127 in Figure 4 or 11, column 9 line 8-9, column 11 line 3-14), an optical to electrical converter (501 or 1301 in Figure 5 or 13), a second digital signal processor (FFT 507 or 1315 in Figure 5 or 13), the outputs of the second digital signal processor are the results of a Fourier transform performed on the input signals, and the combined data rate of the signals carried by the plurality of electrical outputs is at least 10 Gb/s (column 11 line 36-65 and column 15 line 17-21).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the teaching of Agazzi to the system of Smart et al and Shpantzer so that the system can also be used to transmit, receive and output 10 Gbit/s signals and the system bandwidth can be efficiently utilized.

12). With regard to claim 23, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 22 above. And Smart et al further discloses a decoder (e.g., Figure 3B, the De-Modulator 325) having a plurality of electrical inputs in use receiving the outputs of the digital signal processor, and an electrical output (Figure 3B, the De-Modulator 325 receives the outputs of the IFFT and outputs an electrical signal DATA OUT), in use outputting binary data (the DATA OUT. Also, Figure 15 shows the decoders 1512 and 1522).

13). With regard to claim 27, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 22 above. And Smart et al further discloses the digital signal processor comprising

a de-serialiser (Figure 3B, P/S 332) having an electrical input receiving the output of the optical to electrical converter and outputting a plurality of signals obtained by the deserialisation of the input,

a Fourier transform unit (e.g., the IFFT in Figure 3B) having a plurality of electrical inputs, in use receiving the outputs of the de-serialiser, and a plurality of electrical outputs (Figure 3B), in use each carrying a signal representing data carried on a sub-carrier of the optical sub-carrier multiplexed signal ([0028], [0073] and [0081]-[0088] etc., the IFFT perform FFT based on the orthogonal frequency division multiplexing),

wherein the electrical outputs of the Fourier transform unit are the result of a Fourier transform performed on the inputs (the IFFT performs the Fourier transform on the inputs).

14). With regard to claim 28, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claim 22 above. And Smart et al further discloses a forward error correction decoder connected to the digital signal processor, in use performing error correction on the data ([0082], the demodulator 325 demodulates the carriers to extract the output data; and "other conventional operations, such as framing, blocking, and error correction can also be provided").

15). With regard to claim 32, Smart et al and Shpantzer et al and Agazzi disclose discloses all of the subject matter as applied to claim 22 above. And Smart et al and Shpantzer et al and Agazzi further disclose the apparatus comprising an optical demultiplexer (Shpantzer: e.g., the Demux 230 in Figure 2a, and 1102 in Figure 11) having an optical input in use receiving the plurality of optical sub-carrier multiplexed signals (Shpantzer: Figures 2 and 11), and a plurality of optical outputs (the outputs from the Demultiplexer in Figure 2 and 11) in use each output carrying at least one of the optical sub-carrier multiplexed signals, wherein the outputs are connected to the receivers (Shpantzer: e.g., 1110 in Figure 11).

6. Claims 2, 21 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smart et al and Shpantzer et al and Agazzi as applied to claims 1, 20, 22 and 23 above, and in further view of Sandell et al (US 2004/0131011).

1). With regard to claims 2 and 21, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 1 and 20 above. But, Smart et al and Shpantzer et al and Agazzi do not expressly disclose where the spacing of the sub-carriers in the sub-carrier multiplexed signal is substantially equal to an integer multiple of 1/(Symbol period).

However, the OFDM is used in Smart's system, and Sandell et al teaches that the subcarriers are orthogonal if they are spaced apart in frequency by an interval of 1/T, where T is the OFDM symbol period. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the sub-carrier

spacing as taught by Sandell et al to the system of Smart et al and Shpantzer et al and Agazzi so that the sub-carrier signals are orthogonal and interferences can be reduced.

2). With regard to claim 26, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 22 and 23 above. But, Smart et al and Shpantzer et al and Agazzi do not expressly disclose wherein the decoder comprises a maximum likelihood sequence estimation decoder.

However, as disclosed by Sandell the maximum likelihood sequence estimation (MLSE) is the conventional channel estimation technique ([0019]), in which a most probable received sequence is chosen from a set of all possible received sequences. MLSE decoding can incorporate detailed knowledge of the statistical properties of noise and crosstalk and other channels parameters into the decision process, therefore improving performance in the presence of these impairments.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the MLSE technique as widely used in the art to the system of Smart et al and Shpantzer et al and Agazzi so that the decoder can efficiently and accurately decode the signals in the present interferences.

7. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smart et al and Shpantzer et al and Agazzi as applied to claim 1 above, and in further view of Sandell et al (US 2004/0131011) and Fee (US 2004/0223759).

Smart et al discloses all of the subject matter as applied to claim 1 above. But, Smart does not expressly an electrical signal generator, connected to an input of the

modulator, wherein a small depth modulation is imparted on the optical sub-carrier multiplexed output signal.

However, to insert a reference signal or pilot signal to the SCM signal is well known in the art. Sandell et al teaches an electrical signal generator to generate a pilot signal for determining a channel estimate (amplitude change and phase shift etc.) ([0008], [0026] and [0030]). But, Sandell et al does not expressly state wherein a small depth modulation is imparted on the optical sub-carrier multiplexed output signal.

Fee, in the same field of endeavor, teaches a monitoring signal with a small depth modulation imparted on the optical carrier output signal (Figures 6-9). By monitor the modulation tone or the superimposed signal, the signal transmission quality can be deduced and monitored.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the reference signal as taught by Sandell et al and Fee to the system of Smart et al and Shpantzer et al and Agazzi so that the channel estimation can be readily determined.

8. Claims 24, 25, 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smart et al and Shpantzer et al and Agazzi as applied to claims 22, 23 and 28 above, and in view of Maltsev et al (US 7,286,609).

1). With regard to claims 24 and 25, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 22 and 23 above. But, Smart et al and Shpantzer et al and Agazzi do not expressly state that the decoder comprising a serialiser having a plurality of inputs receiving the outputs of the digital signal processor,

and an output outputting a signal derived by the serialisation of the input signals; and wherein the output data is determined by the comparison of the input signals with a predetermined value.

However, Maltsev et al, in same field of endeavor, teaches a SCM transmission system and method that comprises a decoder (e.g., Decoder 230 and P/S 232 in Figure 2) having a plurality of electrical inputs in use receiving the outputs of the digital signal processor and an electrical output (the output 234 in Figure 2), in use outputting binary data (the output 234 in Figure 2); and the decoder comprising a serialiser (e.g., the P/S transform block 232 in Figure 2) having a plurality of inputs receiving the outputs of the digital signal processor, and an output outputting a signal (the signal 234 in Figure 2) derived by the serialisation of the input signals; and the output data is determined by the comparison of the input signals with a predetermined value (column 5, line 48-53, column 7, line 31-32, column 8 line 22-42, column 11 line 8, and column 13 line 52-54).

Maltsev et al provides high throughput and reduced interference and less expensive system. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the receiver structure as taught by Maltsev et al to the system of Smart et al and Shpantzer et al and Agazzi so that a high quality and less expensive receiver can be utilized.

2). With regard to claims 29 and 30, Smart et al and Shpantzer et al and Agazzi disclose all of the subject matter as applied to claims 22 and 28 above. But, Smart et al and Shpantzer et al and Agazzi do not expressly disclose the apparatus further comprising apparatus to determine channel state information of the sub-carriers; and

wherein the channel state information is utilised by the forward error correction decoder to improve the performance of the error correction.

However, Maltsev et al teaches an apparatus that determines channel state information of the sub-carriers (Figure 2, the channel state information 236 is provided to the SMA 202); and the channel state information is utilised by the forward error correction decoder to improve the performance of the error correction (column 5, line 15-49, and column 2, line 1-24, the SMA controls the decoding of individual ones of the received subcarrier based on the CSI etc.)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the channel state information as taught by Maltsev et al to the system of Smart et al and Shpantzer et al and Agazzi so that the decoder can efficiently and accurately decode the signals based on the channel state information etc.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LI LIU whose telephone number is (571)270-1084. The examiner can normally be reached on Monday-Friday, 8:30 am - 6:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ken Vanderpuye can be reached on (571)272-3078. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Li Liu/
Examiner, Art Unit 2613
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